Class C Cargo Compartment ULD Suppression Agent Penetration

Presented to: International Aircraft Systems Fire Protection Working Group. Dresden, Germany

By: David Blake, FAA Fire Safety

Date: May 12-13, 2015
Background

• Recent test results have shown the potential for vapors vented from lithium ion batteries in thermal runaway to produce flammable gas mixtures inside ULDs.

• Based on those results, questions arose about the ability of Class C cargo compartment Halon 1301 suppression agent to penetrate into ULDs to inert these flammable gas mixtures.

• **FE-25 used as a surrogate gas for Halon 1301.**

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<thead>
<tr>
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<th>Halon 1301</th>
<th>FE-25</th>
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<tbody>
<tr>
<td>Boiling Point (°F)</td>
<td>-72</td>
<td>-55</td>
</tr>
<tr>
<td>Vapor Pressure (psi)</td>
<td>208</td>
<td>200</td>
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<tr>
<td>Molecular Weight (g/mol)</td>
<td>149</td>
<td>120</td>
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</table>
DC-10 Test Article Aft Cargo Compartment

Compartment Volume: 1303 ft$^3$

May 12-13, 2015 Dresden, Germany
Four continuous gas analyzers calibrated for FE-25 are available to simultaneously record gas concentrations. The probes will be located inside and outside of the ULDs.
20 lbs FE25 discharged into empty compartment with mixing fans. Gas probes spaced equidistant between floor and ceiling. Cabin ventilation fan on.

Leakage calculated from agent decay rate: 38.7 ft$^3$/minute.
AKE Unit Load Devices (ULDs) with flexible fabric door covering. Filled to approximately 85% with cardboard boxes filled with bubble wrap plastic and taped closed.
Initial Gas Probe Locations (Some ULDs removed from drawings for clarity)
Interior Gas Probes 3 and 4
Theoretical Agent Exponential Decay Curves

\[ c = c_0 \cdot e^{-t/T} \]

T = Effective time for one air change

Comp. Leakage = 39 CFM
Comp. Volume = 1303 ft\(^3\)
Agent Quantity = 21 lbs.
Loaded Compartment Test 1. 24 lbs FE-25
Loaded Compartment Test 2. 21 lbs FE-25
• Test results are very preliminary. No conclusions should be drawn at this point.

• Additional testing will be conducted to understand preliminary results. (Installation of pressure transducers, sealing of pressure relief valves, etc.)

• Probe locations will be varied after initial results are better understood.

• Input and test data from others is welcome.